A METHOD AND SYSTEM FOR ROUTING A CALL BETWEEN CELLULAR SUBSYSTEMS

The present invention relates to a method and a system for telecommunication and more particularly to the integrated use of public and private communication networks.

Telecommunications have undergone a rapid change since the first digital cellular phones entered the market. Digital mobile technologies like GSM can now offer equivalent, if not better voice quality than the normal fixed line telephone. This, in addition to the obvious advantage of mobility, has been a reason for the increasing use of cellular telephones. In many cases cellular phones have become the phones of choice over the fixed line, even inside offices. A mobile communication connection, anyhow, is typically more expensive than a fixed connection. Thus the opportunity to use wireless connections outside the office tends to increase the general cost of calls for a company, as subscribers typically use the communication method that provides the best availability.

Another notable trend has been the introduction of many new products for IP Telephony systems. IP Telephony is an emerging set of technologies that enables voice, data and video collaboration over existing IP-based Local Area Networks (LAN), Wide Area Networks (WAN), and the Internet. IP Telephony has many advantages and one of them is its use as a cost-efficient way of implementing conventional telephony services, e.g. making long distance calls.

In the past, organisations have deployed separate networks to handle traditional voice, data and video traffic. Each with different transport requirements, these networks are expensive to install, maintain and reconfigure. Typically, also a separate terminal for each network is needed, which increases the costs and complicates things from the user's point of view. Furthermore, since these networks are physically distinct, their integration is very difficult, thus limiting their potential usefulness.

In Private Branch Exchanges (PBX) a conventional way of saving expenses in internal calls, fixed and mobile, is routing by internal short-dialling numbers. Such a method, anyhow, requires number information, which is typically not at hand when needed. A user relying on his personal telephone directory stored in the memory of his mobile terminal is often reluctant to maintain and use several numbers for one person, and the mobile subscriber number is often used, thus routing the call outside the office infrastructure. In this text and all of the following text "office" stands for an environment with several users, which users have a connection to a business entity, e.g. a company, and are permanently or temporarily authorised to access communication services provided by that entity.

Dual-mode phones accessing a local private network (e.g. DECT) while in the office and a public network (e.g. GSM) outside of the office are also suggested. In such a system the numbers can be mapped so that a subscriber can be reached using a single number. Such a solution, anyhow, requires the building and maintaining of overlapping communication networks in the office and still the services, e.g. Internet access away from one's desk is limited to a relatively narrow range of applications.

A recent means of connecting switches to computer systems is to use Computer Telephony Integration (CTI) gateways. CTI is most frequently used in environments where repositories of information, such as databases, must be accessed with each incoming call. This enables the person responding to the incoming telephone call to receive additional information about the client, e.g. previous buying history, preferences, geographical location, etc. However, the use of such CTI applications requires that switches are accessed through the open application programming interfaces provided by the gateways. Furthermore, in present CTI systems, voice and data are not actually consolidated but operate parallel to each other.

Now a communication system has been invented, wherein these problems and restrictions are overcome or their effects are remarkably reduced. In the invented

solution, new network elements are introduced to link the office network with the public mobile network so that when the user is in the office premises, the calls are routed to him through the office communication network, and when the user is outside the office, the calls are routed to him through the public mobile network. The interface to the mobile terminal remains the same disregarding the routing so that a conventional mobile terminal can be used in the office and outside it. When the user is in the office, the mobile subscriber number of the mobile network is mapped to the relevant network address thus enabling the use of only one subscriber number for addressing one subscriber. Intra-office calls, i.e. calls between parties with access to office network, are routed through the office network thus keeping the traffic and accordingly generating costs only within the office infrastructure.

According to a first aspect of the present invention there is provided a communication system, comprising a network switching system and a first subsystem comprising one or more base stations for communicating with mobile terminals via an air interface; and a second subsystem comprising one or more base stations for communicating with the mobile terminals via an air interface. The second subsystem is accessible by a first group of mobile subscribers of the communication system, and comprises one or more network elements for transforming signals from the network switching system into data packets of the second subsystem and for transforming data packets from the second subsystem into signals of the network switching system, one or more network elements connected with one or more base stations of the second subsystem for transforming signals of the network switching system from the base station into data packets of the second subsystem and for transforming data packets from the second subsystem into signals of the network switching system for the base station. Said second subsystem further comprises means for delivering data packets in the second subsystem according to a network address assigned to network elements of the second subsystem; and means for mapping a number identifying a mobile subscriber in the communication system to a network address

of the second subsystem when the mobile terminal of the mobile subscriber is able to communicate with a base station of the second subsystem.

Further aspects of the invention are presented by the network elements as claimed in the independent claims 9 and 14, and by a method as claimed in the independent claim 16. Preferred embodiments of the invention are presented with dependent claims.

From the user perspective, the benefit of the invention derives from the fact that the functions required for optimising the routing are transparent to him. Mobility in the office and outside it is extensively supported, but the task of considering the costs arising from the use of different networks no longer concerns the employee. One number can be used for one subscriber without considering whether the call is within the office or not. Furthermore, computer telephony integration enables a broad spectrum of enhanced services.

From the company perspective, further benefit of the invention derives from the fact that the quality and the quantity of services can be increased without increasing the costs. In many cases costs can even be decreased. Through computer telephony integration an increased manageability and adaptability of services is reached leading to a better service to the customer, which increases productivity in general.

Office network is preferably an IP (Internet Protocol) based network, which may be a simple LAN or a complex interconnected corporate WAN. Public mobile network is preferably a digital Public Land Mobile Network (PLMN) provided and maintained by the operator and providing cellular coverage to a mobile terminal in a considerably larger area than the office premises. Though systems supporting any standard or any multiple access schemes (Time Division Multiple Access, Code Division Multiple Access) can be used, due to its extensive global coverage GSM system is used here as a preferred embodiment.

For a better understanding of the present invention and in order to show how the same may be carried into effect reference will now be made, by way of example, to the accompanying drawings, in which:

Figure 1 illustrates the basic concept of invented system;

Figure 2 illustrates handling different type of services through one network;

Figure 3 illustrates the scope of H.323 specification;

Figure 4 illustrates different core functions of the invented solution and the way they are arranged in relation to the access functions;

Figure 5 illustrates the architecture of the invented system;

Figure 6 illustrates the implementation of the storage and retrieval functions concerning mobile subscriber information managed by the Intranet Location Register;

Figure 7 illustrates a functional architecture of the A-Gateway Element;

Figure 8 illustrates the architecture of the ISDN/IP Gateway;

Figure 9 illustrates the functional architecture of the Intranet Mobile Cluster

Figure 10 illustrates functional units and interfaces of the WIO Gatekeeper;

Figure 11 illustrates functional elements of the Intranet Mobile Cluster;

Figure 12 illustrates interfaces of the presented embodiment;

Figure 13 illustrates the method of routing calls in the invented system;

The block diagram in Figure 1 illustrates the basic concept of invented system using GSM as the public mobile network. In a conventional GSM system mobile stations MS are in connection with base stations BTS using radio communication. The base stations BTS are further, through a so-called Abis interface, connected to a base station controller BSC, which controls and manages several base stations. The entity formed by several base stations BTS and a single base station controller BSC controlling them are called a base station subsystem BSS. Particularly, the base station controller BSC manages radio-communication channels, as well as handovers. On the other hand, the base station controller BSC is, through the so-called A interface, in connection with a mobile services switching centre (MSC), which co-ordinates the establishment of connections to and from mobile stations. Through the mobile services switching centre MSC, a

connection can further be established to a subscriber not operating under the mobile communication network.

In the invented system a base station BTS in the office WIO (Wireless Internet Office) premises is functionally connected to a office network LAN, which is connected through a IP network to the MSC. When the MS is within the coverage of the base station BTS mobile terminating and mobile originating calls, as well as other services e.g. GSM data, fax and short messages will be handled via office network LAN. When the MS is not within the coverage of a base station BTS, services will be handled in a conventional way via BSS.

It should be noted that Figure 1 is a simplified illustration of the solution. There can be more than one MSCs and they can be connected to several other communication networks, e.g. PLMN, PSTN and ISDN. The LAN can be connected to an other LAN of the same business entity in another location and they can be connected by IP/Intranet.

Traditionally, different types of media, i.e. voice, data and video have been delivered separately. The recent development of IP Telephony is focusing of handling different type of services through one network, as shown in Figure 2. IP Telephony blends voice, video and data by specifying a common transport medium, IP, for each. Specifically, IP Telephony uses open IETF (Internet Engineering Task Force) and ITU (International Telecommunication Union) standards to move multimedia traffic over any network that uses IP thus offering users both flexibility in physical media (for example, plain old telephone service lines, ADSL, ISDN, leased lines, coaxial cable satellite and twisted pair) and flexibility in physical location. As a result, the same ubiquitous networks that carry Web, e-mail and data traffic can be used to connect to individuals, businesses, schools and governments world-wide.

As a preferred embodiment for office network protocol ITU standard H.323 is used. H.323 is an open standard for multimedia communications (voice, video and

data) over connectionless networks, often thought of as the "Internet" videoconferencing standard, but actually designed to support any combination of audio, video and data and be implemented on any LAN protocol (IPX, TCP/IP). The block chart of Figure 3 illustrates the scope of H.323 specification (dotted line). H.323 provides for call control, multimedia management and bandwidth management for point-to point and multipoint conferences. H.323 mandates support for standard audio and video codecs and supports data sharing via the T.120 standard. H.323 is also network, platform and application independent, allowing any H.323 compliant terminal to inter-operate with any other terminal.

H.323 allows multimedia streaming over current packet switched networks. To counter the effects of LAN latency, H.323 uses Real-time Transport Protocol (RTP), which is an IETF standard designed to handle the requirements of streaming real-time audio and video over the Internet. Overhead per packet in H.323 are 12 bytes for RTP header, 8 bytes for UDP, 20 bytes for IP and about 1-3 bytes for link-level header and framing. Any H.323 client is guaranteed to support the standards H.261 and G.711. H.261 is an ITU standard for video codec design to transmit compressed video at a rate of 64 kbps and at a resolution of 176x44 pixels (QCIF). G.711 is an ITU standard for audio codec designed to transmit A-law and μ-law PCM audio bit rates of 48, 56, and 64 kbps. Optionally H.323 client may support additional codecs like H.263 and G.723. H263 is an ITU standard video codec and G.723 is an ITU standard audio codec designed to operate at very low bit-rates.

For system control H.323 standard specifies three command and control protocols, wherein H.245 is responsible for control messages governing operation of the H.323 terminal, including capability exchanges, commands and indications. H.225.0 (Q.931) is used to set up a connection between two terminals and RAS governs registration, admission and bandwidth functions between endpoints and gatekeepers.

For a H.323 based communication system the standard defines four major components. *Terminals* are the client endpoints on the network. All terminals must support voice communications; video and data support is optional.

Gateways bridge H.323 conferences to other networks or communication protocols. Gateways are not required if connections to other networks, or non-H.323 compliant terminals, are not needed.

Gatekeepers perform two important functions: address translation, and bandwidth management. These functions help the gatekeeper to maintain the healthy state of the network. The Gatekeeper also exercises call control functions to limit the number of H.323 connections, and the total bandwidth used by these connections, in a H.323 "zone." One H.323 zone is a collection of all terminals, gateways and multipoint control units (MCU) managed by a single gatekeeper. A Gatekeeper is not required in a H.323 system. However, if a Gatekeeper is present, terminals must make use of its services.

Multipoint Control Units support conferences between three or more endpoints. An MCU consists of a required Multipoint Controller (MC) and zero or more Multipoint Processors (MPs). The MC performs H.245 negotiations between all terminals to determine common audio and video processing capabilities, while the MP routes audio, video, and data streams between terminal endpoints. An MCU is also optional.

The invented system is based on utilising the recent development in integrated communication systems for combining public mobile network with private networks in a way that is advantageous for different parties in the processes. Furthermore, for implementing said invented system new elements have been invented.

In Figure 4 a description of different core functions of the invented solution and the way they are arranged in relation to the access functions is presented. From the corporate perspective the invented system enables company wide

telecommunication services provided internally using data communication resources. For public access, co-operation with the local telecommunications operator is necessary. From the operator perspective, users of the invented system may share the resources of a public TCP/IP interconnection service, telecommunication networks and end user service access points, but use private LANs to access the public network side and other users within the company WAN. Appreciating the fact that PBX industry working on CTI is moving the development of end-user services and applications to computer environment, the potential synergy in developing value added services and multimedia services is apparent. The core functions of the invented system include directory services, call control service, mobility management, operation and maintenance, billing, quality of service guarantee and security services. Figuratively speaking the invented system can be seen as a new kind of GSM BSS/NSS with a specific location register or as an extension to the packet based multimedia communication system specified in the H.323 Recommendation.

In Figure 5, the architecture of the invented system is illustrated. As can be seen, all new network elements are located between A-interface and Abis-interface. In the following, the term WIO (Wireless Internet Office) is used for the entity that comprises the new functions and new elements in the invented system, anyhow not limiting the scope of protection to any of the names of the products associated with the invented system. WIO has at least three different gateways AGW, IGW, IMC each having different interfaces to separate parts of the GSM or the H.323 network. It should be noted that the gateway function according to H.323 is only one of the functions these components take care of.

In the operator side the WIO block comprises network elements AGW, IGW and ILR, the purpose and functions of which are now explained in more detail.

The purpose of A-interface gateway AGW is to handle communication between the office network and the public mobile network through MSC. AGW provides both signalling and traffic routing between the office network and MSC, and

thereby forms a BSS interface to the MSC. From the MSC point of view WIO thus looks like one or more BSSs with a certain Location Area Code (LAC). AGW can be connected to the MSC directly with A-interface. Anyhow, AGW does not necessarily need to provide transcoding functions, and therefore it can alternatively be connected using a Ater-interface to a transcoder (e.g. Nokia Transcoder TCSM2) typically arranged between the MSC and BSC. The transcoding function is thereby not performed in the AGW unit itself, but the function of the AGW is to convert PCM based traffic into IP and vice versa.

In Figure 7 a functional architecture of the AGW is illustrated. As the signalling between the AGW and the MSC follows the standard signalling and interfaces, there are no restrictions regarding the use of the MSC. AGW is preferably implemented with a computer, e.g. NT server. The performance of AGW depends both on the server configuration as well as the used LAN (IP stack throughput, Ethernet, etc.). However, one logical AGW can be realised as a cluster of servers. Depending on the configuration the number of supported voice traffic channels varies. For example, to support one multiplexed E1 connection, a configuration of two servers is needed, thus creating around 120 traffic channels.

The functions of the AGW comprise at least most of the following:

- signalling conversion and termination: A-interface – WIO
- traffic routing: Ater interface – WIO
- Ater / A-interface channel management
- TRAU (Transcoding and Rate Adaption Unit) frame handling
- IP DTX (discontinuous speech over IP)
- transcoder (TCSM2E) control
- support for WIO Operation and Management (O&M)
- creating traffic and load statistics
- pool option (possibility to cluster servers together).

The signalling between all the WIO components is preferentially encrypted, and this relates to also to communication between the unit implementing O&M and

AGW. AGW typically collects statistical information of its central transactions and especially of detected failures and disturbances. WIO Gatekeeper elements (presented later) constantly control status of other WIO network elements, and hence AGW provides responses to those enquiries as well. Ongoing WIO calls are disconnected by MSC. In case WIO network connection breakdown, AGW closes temporarily also the MSC signalling link.

The second element in the operator side is the ISDN/IP Gateway (IGW) that manages communication between WIO and the public telephone network, and it is a gateway that is typically defined in the CTI concept. Preferably Digital Signalling System No. 1 (DSS.1) is used. In Figure 8 a functional architecture of the IGW is illustrated. IGW has an interface to both MSC and PSTN. From MSC point of view IGW looks like a PBX. IGW supports transcoding between ITU-T standards G.711 and G.723 as well as G.711 and GSM 06.10. IGW collects statistical information of its central transactions and especially of detected failures and disturbances, and forwards the information to O&M application through WIO Gatekeeper (explained later). The architecture of IGW is based on a similar hardware as the AGW.

The third element shown in the operator side is Intranet Location Register ILR that takes care of the directory services in WIO. GSM provides a Home Location Register (HLR), which is a register where all subscriber parameters of a mobile subscriber are permanently stored, and one or more Visitor Location Registers (VLR) where all subscriber parameters for call set-up are temporarily stored as long as a subscriber is in a location area controlled by the register. Being part of the state of the art these registers are generally known to a person skilled in the art.

The Intranet Location Register (ILR) is a database taking care of the permanent subscriber data storage in WIO, while on the other hand it is an access manager to subscriber data in the HLR and the billing system. The purpose of the ILR is to provide a storage base for retrieving Mobile Station (MS) specific information

configured for the WIO system. All the MS's configured to WIO have a permanent entry in the database. These MS specific settings are valid when the MS is logged into the WIO system.

Furthermore, the WIO Gatekeeper (explained later in more detail) in the office side updates the mapping of current address of each MS within the WIO region, in the directory. The ILR is connected to the HLR and VLR through the MAP interface. The main task for the ILR towards the HLR, is to retrieve a subscriber's service profile information from the HLR, such as supplementary service settings, etc. The ILR runs e.g. on a Windows NT server based on industry standard Pentium technology. In order to fulfil its tasks well, the server shall provide high-availability, fault-tolerance and fast recovery.

In Figure 6 a more detailed illustration of the implementation of the storage and retrieval functions concerning mobile subscriber information managed by the ILR is presented. It should be noted that the shown interfaces apply to the present embodiment and do not exclude equivalent implementations comprising more or less interfaces. The *ILR Interface* implements storage and retrieval functions concerning mobile subscriber information managed by the ILR. The function makes database related details transparent the WIO Gatekeeper, so that a change in the underlying storage method does not require any changes in the WIO Gatekeeper. The ILR provides the coding and decoding of requests asked for by the WIO Gatekeeper, and also returns information requested by the WIO Gatekeeper.

The HLR Interface is used to retrieve a mobile subscriber's basic information as well as their supplementary service settings from the HLR. MS Gatekeeper location address is stored in the ILR and also the retrieval is carried out in connection with Location Update. The mobile location update request from the WIO Gatekeeper acts as a triggering event for HLR information retrieval.

The VLR interface is used to request a subscriber's IMSI (International Mobile Subscriber Identity), if a mobile station identifies itself with the TMSI (Temporary Mobile Subscriber Identity) during the first location update to the WIO area. In both cases the MAP protocol is used.

The LDAP Interface provides means to retrieve and maintain MS specific information stored in Directory service database connected to the ILR. This information is gathered from different sources like HLR Interface and IN Interface. The protocol used in the communication with Directory service is Lightweight Directory Access Protocol (LDAP).

IN Interface is an optional interface that provides means for retrieving subscriber's additional service information from Intelligent Network e.g. private numbering enabling the use of short codes within WIO. This interface is based on e.g. Service Management Interface (SMI) provided by IN.

Billing Interface provides means for transferring billing related raw data into billing system to be post-processed. In this embodiment local database ILR acts as an intermediate storage for billing information collected by the WIO Gatekeeper.

In the office side of the WIO, the network elements Intranet Mobile Cluster IMC and WIO Gatekeeper GK are shown in Figure 5. As mentioned earlier, the Intranet Mobile Cluster (IMC) is substantially a gateway in H.323 terminology, and it is simulating the actions of the BSC in the WIO environment. The IMC uses LAPD based Q.931 and GSM specific signalling and generates TRAU frames for speech and data for an Abis interface. It also manages the radio resources and channel configurations, and handles configuration of the BTS. The IMC provides GSM signalling and stream conversions to other WIO components. It also detects the need for possible handover and power control actions during a call.

IMC core functionalities illustrated by the functional layers of Figure 9 towards WIO cover running CVOPS with GSM signalling protocols, running WIO system

control and IP ciphering, controlling the socket interface towards the WIO Gatekeeper and controlling the socket interface towards the GSM/IP traffic option on the LAPD server. The main functions of the IMC towards BTS are:

- BTS control and management
- radio resource control and management
- radio network control and management
- radio channel configuration and management
- IP DTX
- RF frequency hopping
- handover algorithm and target cell list reporting
- handover management
- speech conversion from IP traffic to G.703 and TRAU frame generation to the Abis side.
- IMC state management
- radio object state management
- IMC and radio access fault management
- status report generation.

The IMC is typically implemented as a radio-controlling unit, which is based e.g. on a Pentium®PC with an E1 interface card.

IMC comprises substantially three functional elements as illustrated in Figure 11. The Radio Access part 111 comprises a radio receiver 112 and transmitting unit 113, E1 interface 114. The Data Processing Unit 116 is typically implemented with a computer; e.g. a Pentium® based NT computer. The DPU 116 further comprises three functional elements: Radio Resource Handling Unit 117, Operation and Maintenance Unit 118 and Telecommunication Unit 119. WIO Interface Unit 120 is preferably a LAN interface card supporting a number of physical connections.

The second element shown in the office side in Figure 5 is the WIO Gatekeeper. Gatekeeper is typically an element for providing services such as call forwarding, automatic re-routing and detailed departmental billing in an IP network. WIO

Gatekeepers tasks in the WIO system comprise furthermore providing call control services to the WIO endpoints.

The tasks the Gatekeeper comprise at least most of the following:

- address translation functions
- bandwidth management
- call management
- mobility management
- giving paging requests to the IMCs (explained later)
- checking service profiles and authorisation of WIO services
- collecting call data records (CDR)
- forwarding call data records to the ILR
- offering an interface for the O&M application
- checking functionality of other WIO components
- taking care of terminal registration and status handling.

Some of these are well known to a person skilled in the art and some will be explained here in more detail. Gatekeeper comprises several functional units and interfaces that are illustrated in Figure 10.

Device Management 101 is responsible for status hàndling of other WIO entities as well as terminal registration. Device Manager stores WIO specific information to the Device Database 102.

Operation and maintenance 103 comprises an optional WIO Gatekeeper charging function, which collects information from calls, creates charging records (CDR) out of them and sends them to the ILR.

Call Management 104 can be defined as a set of functions that enable and control telecommunications between two or more parties. In the invented solution Call Management provides a scaleable basic infrastructure and creates an extensible platform for new advanced services. Call Management is needed to support

information such as mapping IP addresses and phone numbers to each other. The WIO Gatekeeper is arranged to manage different call types, such as voice, data, facsimile, SMS, and conference calls. These calls can be established between two of the following: a mobile station, a network terminal and a fixed telephone. The call between a fixed and a mobile phone is established through MSC as long as there is no gateway between the PBX and the WIO infrastructure.

Gatekeeper manages both internal and external calls. Internal calls are calls that are made either under the same WIO Gatekeeper, or between subscribers under two different WIO Gatekeepers of one office. External calls, are calls where either of the subscribers does not have access to the office network.

WIO Gatekeeper manages a location area. When a subscriber in the office is called from the external network, the call is routed by the IGW or the AGW to the WIO Gatekeeper under which the called mobile station is currently located. The location data is queried by the IGW or the AGW from the ILR. After this the WIO Gatekeeper sends a broadcast-paging message to each IMC within the zone it is managing and routes the call to the right one.

In another case both subscribers are in the area of the same Gatekeeper. Then the WIO Gatekeeper, detecting that the B-subscriber is under the same WIO Gatekeeper, sends a Paging broadcast message to each IMC under it. The IMC where the subscriber is registered to sends its answer to the WIO Gatekeeper, and the gatekeeper routes the call to this IMC.

In a situation where a subscriber in the office is calling a subscriber outside the office, the WIO Gatekeeper checks the location of subscriber B. If it does not find the subscriber B, WIO Gatekeeper routes the call to the MSC through the AGW.

Mobility management 105 includes tasks related to the mobility of the user, such as location updates and handovers. Location update is done each time a new subscriber having access to the office network arrives in the office environment.

Also other subscribers (e.g. visitors) are preferably allowed to make location updates in WIO, however, their calls are routed through the MSC. This function is preferably configured so that the operator can allow external subscribers to use base stations connected to WIO as well. Inside WIO the subscriber information is received from the ILR.

A handover request message is sent to the WIO Gatekeeper by the IMC. This message includes a list of the best target cells. Handovers that work in the normal GSM network also work in WIO. One exception, however, is a handover from WIO to an external non-WIO cell. This is not possible if the phone call is an internal, non-MSC controlled call. If the phone call is a MSC controlled call, it means that A-subscriber is inside the office, and B-subscriber is outside the office, and handover is, in this case, possible. The exception provides for the tariffing scheme, which can be different for intra-office calls (i.e., low tariff or even free of charge). It is advantageous to have means to control the implementation of this special tariffing whenever the calling or the called mobile station is moving outside office coverage.

The Gatekeeper preferably collects statistical information from all transactions made in WIO (i.e. voice and data call, facsimile, SMS, failed call, etc.). This information is stored to the file, then delivered to the ILR if the information is needed for billing purposes. The billing interface in the ILR collects information relating to 'call data records' (CDR), and sends it to the billing system.

It should be noted that the division of the functionalities between the IMC and the WIO Gatekeeper apply for the embodiment shown here. Equivalent applications can be implemented by changing or dividing the functionalities differently to either or both of the elements.

As shown earlier, interfaces related with WIO comprise substantially standard interfaces. In Figure 12, interfaces of the presented embodiment are illustrated. WIO has two interfaces towards MSC. One is realised with IGW and the other

one with AGW. IGW fulfils the DSS.1 standard requirements by providing layer 2 (LAPD) and layer 3 (Q.931) protocol services. The MSC interface is compliant with several standards, like E1, 2048Mbit/s (based on G.703 and G.704), LAPD (Q.921) and Layer 3 where standards Q.931 and Q.932 are used. IGW uses D"".1 standard also towards PBX and PSTN. Towards Mobile station, cellular standard e.g. GSM is used. The ILR implements MAP interface towards the HLR and VLR. WIO Gatekeeper uses H.323 protocol to communicate with other WIO entities in the following way:

- PC terminal and WIO entities are registered to the WIO Gatekeeper by RAS channel
- Q.931 channel is used during call establishment
- H.245 is used during calls for capacity, codec and multipoint call control
- WIO uses Routed Signalling Model based on the H.323 standard. All signalling between WIO Gatekeeper and other WIO elements are preferably encrypted.

The following interfaces are supported in WIO elements of this embodiment:

- LAN interface
- WinSock2
- RTP/RTCP to control voice packet transmission in UDP datagrams.

In Figure 13, the method of routing calls in the invented system are illustrated. As an example steps related to a Mobile Originating call from a WIO subscriber in the office environment is presented. In step 131 the IMC receives a call set-up request from the subscriber A comprising the number of the subscriber B. The request is delivered to the WIO Gatekeeper that will check from the ILR (step 132) whether the subscriber B is a WIO subscriber or not (step 133). If the subscriber B is a WIO subscriber, WIO Gatekeeper pages all IMCs it controls (step 134) and checks whether it receives an answer (step 135). If, for some reason, no answer is received, the call will be cancelled (step 136). If the IMC to which the BTS communicating with the MS of the subscriber A answers, a connection is established by the IMC elements of subscriber A and subscriber B (step 137). If the subscriber B is not a WIO subscriber, WIO Gatekeeper will route the call via

AGW (step 139) to the MSC, and the call set-up will be implemented in a conventional way (step 140), though the data transfer involves both GSM and H.323.

Although the invention has been shown and described in terms of a preferred embodiment, those persons of ordinary skill in the art will recognise modifications to the preferred embodiment may be made without departure from the scope of the invention as claimed below.